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CARBON CAPTURE FARMING

A new future for subsided Delta lands?

The U.S. Geological Survey (USGS), the University of California, Davis and the California Department of Water Resources (DWR) are working to develop a new, economically sustainable way to rebuild the unique peat soils of the Sacramento-San Joaquin Delta and permanently take carbon dioxide (CO_2) out of the atmosphere.

The concept, "carbon-capture farming," promotes the growth of wetland plants like tules and cattails that capture atmospheric CO_2 through photosynthesis. As the plants die and decay, their root mats and other decayed material build up the soil on fragile Delta islands that have subsided, or sunk, below the level of surrounding waterways.

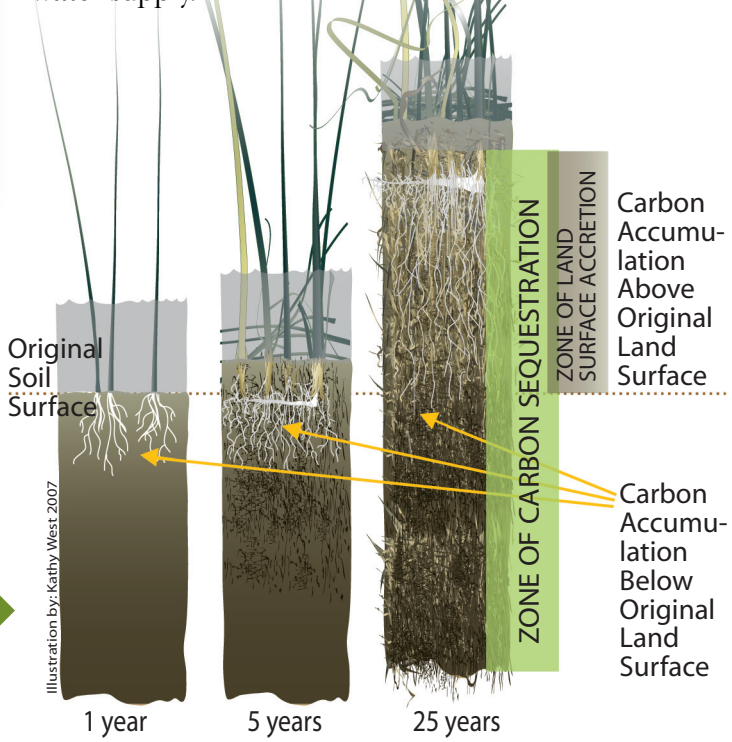
The agencies are launching the first-ever Carbon-Capture Farming Demonstration Project that will research ways to safely bring this concept to full scale in a scientifically sound way. Spreading across hundreds of acres, the project will develop wetland management approaches that maximize carbon sequestration and subsidence reversal, and minimize the potential for adverse consequences.

How atmospheric CO_2 is fixed by plants and then incorporated into soil biomass as land surface accretes over time. These linked processes have the combined benefits of sequestering atmospheric carbon and rebuilding land surface on subsided Delta islands.

Carbon-capture farming has already shown great promise.

In a pilot project over the last several years, USGS scientists have created two seven-acre wetlands that are "re-building" peat soils and taking carbon out of the atmosphere on deeply subsided Twitchell Island in the Sacramento-San Joaquin Delta. This study shows that this process can sequester as much as 25 metric tons of CO_2 per acre per year while nearly eliminating the CO_2 emissions produced by current farming practices. Those practices cause peat soils to oxidize – to virtually vaporize and blow away.

Building up land surface through sequestering carbon has the added benefit of reducing the hydraulic force on Delta levees, the only barriers that protect below-sea-level islands from the surrounding waterways. In the long term, this could significantly reduce the risk of levee failure and the cost of maintenance while providing greater security to California's water supply.



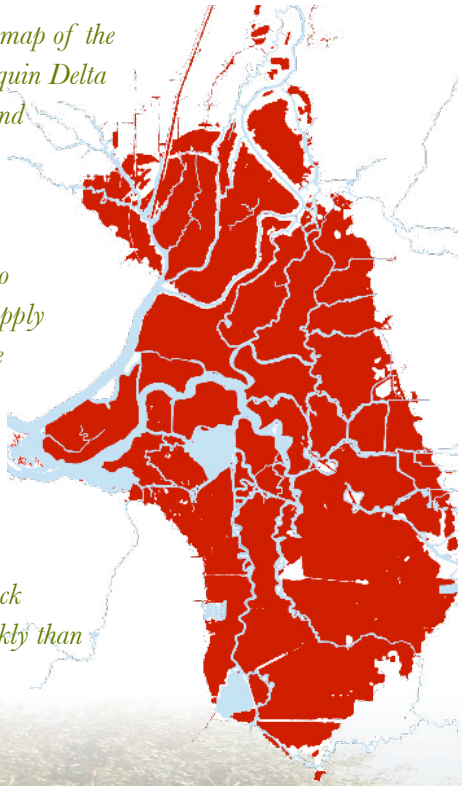
How carbon-capture farming works

HOW BIG COULD THIS BE?

If California converted an area the size of subsided lands in the Delta into carbon farms, the benefits every year would be about the equivalent of…

- **Changing from standard lightbulbs to compact fluorescents in all California households**
- **Turning all SUVs in California into small hybrids**
- **Turning off all residential air conditioners in California**

Subsided lands in the Delta



The red areas on the map of the Sacramento-San Joaquin Delta show the extent of land subsidence below sea level. These subsided lands represent a particular hazard to California's water supply in the event of a levee break. Widespread creation of carbon-capture farms in the Delta has the potential to build land surface back to sea level more quickly than it has subsided

THE R&D EFFORT

The Twitchell Island pilot project has shown that it is highly feasible to use managed wetlands to sequester carbon and reduce subsidence. Additional scientific work is necessary to learn how to maximize growth rates, verify greenhouse gas benefits over several years and minimize any potential adverse environmental impacts.

R&D GOAL 1:
Gaining the best bang for the buck

We know that these carbon capture systems are effective, but there are several questions that need to be answered:

- Can we determine why some portions of the Twitchell Island wetlands are capturing carbon twice as fast as other areas?

- Can conditions be modified to increase carbon capture?
- Would carbon-capture farms perform the same if they were located in other parts of the Bay-Delta Estuary?
- How will climate change affect carbon farms? For example, what will happen if sea levels rise and nutrient loads, water temperatures and salinity increase?

R&D GOAL 2:
Verification of greenhouse gas benefits

The Twitchell Island research has documented significant sequestration, or capture, of CO_2. But wetlands can be emitters of methane and nitrous oxide (N_2O), two other greenhouse gases. Preliminary measurements of methane at Twitchell vary widely, and more monitoring is needed. Researchers have not measured for N_2O, a far worse greenhouse gas. Greenhouse gas impacts also need to be precisely measured at adjacent farmland and for different land-use types in the Delta. Specific questions that need to be answered:

- What are the total greenhouse-gas emissions, including methane and N_2O? How do these emissions evolve as the carbon-capture farm grows over years or decades?
- Are there any surprises in the amount of methane or N_2O emissions?
- What are the greenhouse gas emissions for Delta farmlands and other typical land uses?

R&D GOAL 3:
Do no harm

Large-scale efforts to manage the environment have a decidedly mixed record of success. Our research will address two major areas of concern: production of methyl mercury and transport offsite, and the addition of dissolved organic carbon to Delta waters that are used as drinking water sources. Specific questions about the carbon-capture farms which need to be answered are:

- Do farm conditions which capture the most carbon also produce methyl mercury, and if so, how much, and can the process be managed to mitigate this production?
- How does methyl mercury production and transport in carbon-capture farms compare to production by Delta farms and other typical Delta land uses?
- What levels of mercury are found in the aquatic and terrestrial plants and animals living in the carbon-capture farms that can be attributed solely to methyl mercury being produced in the farm system?
- What amounts and types of dissolved organic carbon are produced in the carbon-capture farm?
- How is the dissolved organic carbon related to conditions driving sequestration and mercury methylation?
- Is the dissolved organic carbon coming off the farms important for the Delta food web and/or of concern to drinking water suppliers?
- Can the carbon-capture farm be managed to control any adverse effects linked to dissolved organic carbon and methyl-mercury production?

THE SCIENCE TEAM

To address these questions requires a team of interdisciplinary researchers with a range of expertise, backed up by professional field technicians working in close collaboration with site engineers. The USGS leads the research team that consists of experts at the University of California at Davis as well as other university researchers and consultants. Planned products include a series of technical reports and a "handbook" on how and where to build and maintain successful carbon-capture farms.

THE CALIFORNIA MARKET FOR SEQUESTERED CARBON

Because of its huge and growing economy, California is the world's 12th largest emitter of greenhouse gasses. The California Global Warming Solutions Act (AB32) requires the State to reduce total greenhouse gas emissions to help mitigate the potential effects of global warming. AB32 requires that the California Air Resource Board use the most feasible and cost-effective means to reduce greenhouse gas emissions. This includes developing a carbon-trading market by 2011, where greenhouse gas reductions, including those from forests or wetlands, may be marketed to industries for which greenhouse gas reductions are prohibitively expensive or impractical. Although the market is not fully established, trading of this nature is already under way, with the value of high quality carbon futures currently trading in the range of $20 per metric ton of CO_2. We anticipate a full carbon marketplace will soon be available for Delta carbon-capture farmers.

For more information about the project, visit:

http://ca.water.usgs.gov/

or contact:

Roger Fujii, rfujii@usgs.gov, 916/278-3055

Brian Bergamaschi, bbergama@usgs.gov, 916/278-3053

Stuart Siegel, Wetlands and Water Resources, 415/457-0250, stuart@swampthing.org

***Robin Miller** has been the lead research scientist on the Twitchell Island pilot project for the past 10 years.*

Project Leadership Team

ROGER FUJII, San Francisco Bay San Francisco Bay and Delta Program Chief for the USGS California Water Science Center, is a soil and water chemist who has long served as lead scientist for the Twitchell Island Wetlands Pilot Project. He is now the supervising scientist for the demonstration project.

BRIAN BERGAMASCHI is the head of the Organic Carbon Research Group of the USGS California Water Science Center, and the chief scientist of the Carbon-Capture Farm Demonstration Project. He received his doctorate from the University of Washington in 1995, specializing in the biogeochemistry of aquatic systems.

STUART SIEGEL is the project manager for the Carbon-Capture Farming Demonstration Project. A wetlands ecologist with more than 20 years' experience, he founded Wetlands and Water Resources in 1996. He has designed, managed, permitted, constructed and monitored dozens of wetland restoration projects in Northern California.

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